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Cardiopulmonary Resuscitation

IMPACT ON HOSPITAL MORTALITY—A TEN-YEAR STUDY

RICHARD L. COSKEY, MD, *Burbank, California*

The effectiveness of cardiopulmonary resuscitation as a vital aspect of health care delivery in hospital was the basis for a ten-year study. All instances of cardiac arrest occurring outside the operating room and nursery were included.

Variations in degrees of success of cardiopulmonary resuscitation as related to the duration of the program, differences among varying subsets such as patients' type of illness and hospital location (emergency room, coronary care unit, intensive care unit or nursing floor) at the time of cardiopulmonary arrest, are presented. The relationship between cardiopulmonary resuscitation frequency and success with increasing instrumentation is reviewed. A simple technique for expressing effect of cardiopulmonary resuscitation on hospital mortality is presented.

The study shows the ability of a community hospital to establish, maintain and document a high level cardiopulmonary resuscitation program.

CARDIOPULMONARY RESUSCITATION (CPR) programs in hospitals have developed into a vital aspect of health care delivery. The effectiveness of CRP programs and relationship to patient age has been well outlined.[1-9]

Government regulations[10] as well as the Revised Joint Statement by the California Medical Association, California Nurses' Association and California Hospital Association[11] and Accreditation Manual for Hospitals[12] have focused on in-hospital CPR programs.

Information on the effect of CPR on modifying in-hospital mortality has not been well outlined. The relationship of patients' primary illness and patient location to the presence or absence of electrocardiographic monitoring on CPR performance has not been presented in detail.

A review of ten years of CPR experience and its modification of hospital mortality forms the basis for this report.

From St. Joseph Hospital Medical Center, Burbank, California. Submitted, revised, June 12, 1978.

Reprint requests to: Richard L. Coskey, MD, Cardiology Consultants Medical Group, Inc., 18370 Burbank Blvd., Suite 707, Tarzana, CA 91356.

ABBREVIATIONS USED IN TEXT
CCU = coronary care unit
CPR = cardiopulmonary resuscitation
ER = emergency room
ICU = intensive care unit

Methods and Patient Population

St. Joseph Medical Center is a community hospital with 411 beds, excluding bassinets. Occupancy had gradually risen from 116,000 in 1967 to 126,000 in 1974. Occupancy data for the first two years of the study were collected using slightly different techniques and are, therefore, not included. There was an approximate 9 percent increase in occupancy over the last eight years of the study. The total number of patients discharged remains in the range of 20,000 per year for the last six years of the study. Patients with a primary cardiac diagnosis constituted 7 percent to 10 percent of the hospital population. The number of electrocardiographic monitors (excluding the surgical suites) increased from 6 in 1964 to 77 in 1974. The CPR program was organized within the Department of Nursing under the guidance and direction of physicians. Full-time physicians trained in emergency medicine have been employed 24 hours a day in the emergency rooms since July 1, 1973. Details of the program have been previously reported.[1]

Cardiopulmonary arrest is defined as the sudden and unexpected cessation of respiration or effective circulation. A patient whose death is anticipated at the end of a chronic illness would not be described as having a cardiopulmonary arrest. All patients were resuscitated if they suffered a cardiopulmonary arrest which could have occurred within the four minutes preceding discovery when there were no physician's orders to the contrary.

Resuscitation was usually initiated by nursing personnel within one minute of onset of asystole or ventricular fibrillation. The interval between arrest and the onset of resuscitation could not be estimated in many of the nonmonitored patients.

Patient data are divided into four categories:

(1) Long-term survivors (patients who have undergone successful resuscitation and have been discharged from the hospital with cerebration unchanged from pre-CPR status);

(2) Short-term survivors (patients successfully resuscitated with cerebration unchanged from pre-CPR status but who died of underlying disease before hospital discharge);

(3) Persons in whom there was successful resuscitation but brain damage, and

(4) Failure (a patient who could not be successfully resuscitated).

TABLE 1.—*Overall Results of Cardiopulmonary Resuscitation Experience, 1965-1974*

	Long-Term Survivors (Percent in Parenthesis)	*Short-Term Survivors (Percent in Parenthesis)*	*Brain Damage (Percent in Parenthesis)*	*Failure (Percent in Parenthesis)*	*Total*
1965	8 (16)	5 (10)	0 (0)	37 (74)	50
1966	14 (25)	4 (7)	9 (16)	30 (53)	57
1967	23 (22)	10 (10)	1 (1)	69 (67)	103
1968	26 (22)	15 (14)	2 (2)	76 (64)	119
1969	30 (23)	22 (17)	0 (0)	79 (60)	131
1970	27 (21)	17 (13)	5 (4)	77 (61)	126
1971	22 (16)	31 (23)	5 (4)	76 (57)	134
1972	35 (27)	37 (29)	4 (3)	52 (41)	128
1973	44 (28)	30 (19)	6 (4)	78 (49)	158
1974	48 (32)	27 (18)	10 (7)	64 (43)	149
Total	277 (24)	198 (17)	42 (4)	638 (55)	1,155

The critical care units comprise emergency room (ER), coronary care unit (CCU) and intensive care unit (ICU). The CCU had electrocardiographic monitoring capabilities for all beds and the ER and ICU for selected beds, in the early years of this study. Later, the ICU also had electrocardiographic monitoring capabilities for all beds.

The remainder of the hospital units were identified as noncritical care nursing units. They initially had no fixed electrocardiographic monitoring capabilities. In the latter years of the study, one nursing unit (32 beds) had complete and another had extensive electrocardiographic telemetry monitoring.

Previous in-hospital studies had included a large number of CPR's occurring in the operating theater.[6] This study excludes arrests in the operating theater.

Overall Results

Table 1 summarizes overall results of the ten-year study. Figure 1 combines short-term and long-term survivors and shows a gradual increment in both number of patients and the percentage of patients successfully resuscitated. Of patients who received CPR in the last three years of the study, 50 percent were short-term or long-term survivors. Figure 2 relates hospital occupancy to the number of electrocardiographic monitors.

Illness

Most of the patients in whom CPR was used, as well as those successfully resuscitated, had underlying cardiac disease. Most of those with cardiac disease were being treated for acute myocardial infarction.

Two thirds of the patients undergoing CPR as well as two thirds of the long-term plus short-term survivors had cardiac disease as the underlying cause of their cardiopulmonary arrest. More than two thirds of the group with cardiac disease had acute myocardial infarction as the primary cause of cardiopulmonary arrest. Of the total, 7 percent had pulmonary parenchymal disease, 5 percent had pulmonary embolization, 7 percent had central nervous system pathologic conditions, 3 percent had cancer and less than 2 percent had drug overdose as the underlying cause of cardiopulmonary arrest.

The percent of long-term and short-term survivors was very similar in comparing patients with cardiac disease, that subgroup with acute myocardial infarction and patients with non-cardiac disease (see Figure 3).

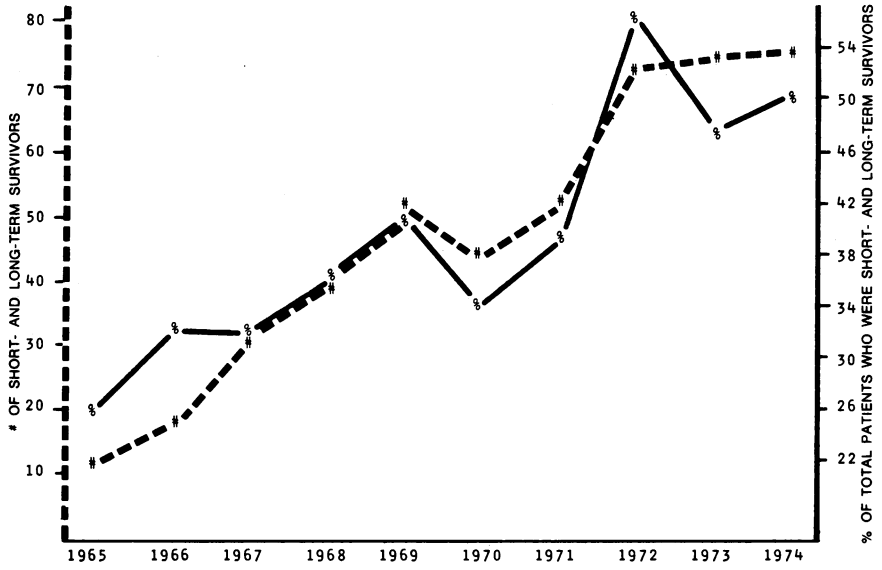

Figure 1.—The number of combined short-term and long-term survivors per year **(dotted line)** and the percent of the total number of patients per year **(solid line)** who were short-term and long-term survivors.

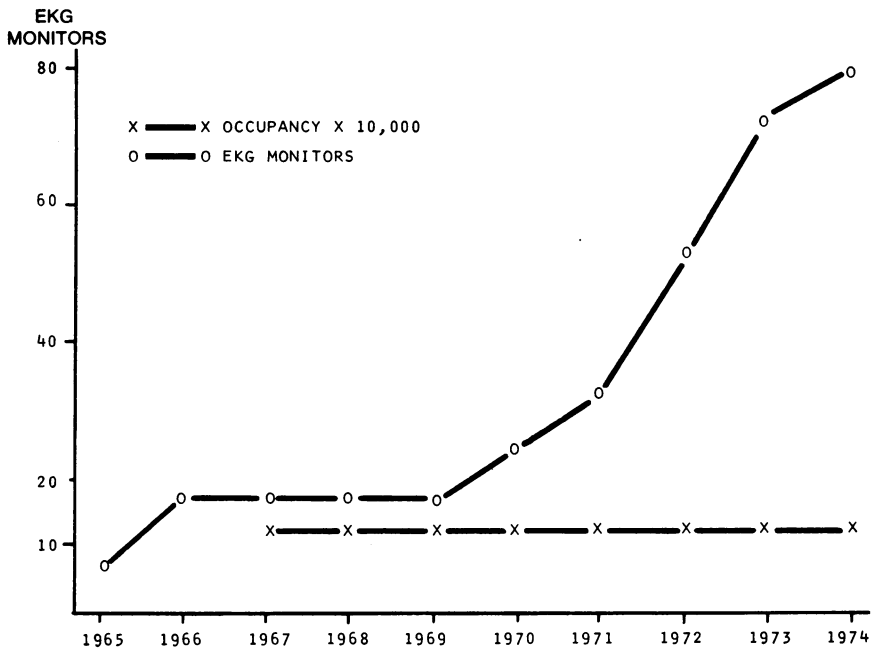

Figure 2.—Hospital occupancy and number of electrocardiographic (EKG) monitors (see discussion in text).

Location in Hospital

Figure 4 summarizes locations within the hospital where CPR was carried out. The years 1965 and 1966 were not included in this tabulation because the coronary care unit began operation in January 1967. The percentage of both long-term and combined long-term and short-term survivors was greatest in the emergency room.

Most of the CPR's were done where patient monitoring was available, such as in CCU, ICU or ER. Some nursing floor units, increasing in latter days of the study, had electrocardiographic monitoring capabilities, but those units are not separately identified.

CPR and Its Effects Upon In-Hospital Mortality

A long-term survivor is a patient who would have died during his hospital stay but was successfully resuscitated and able to be discharged due to successful resuscitation. The number of long-term survivors divided by the number of hospital deaths plus long-term survivors gives the index of the overall success rate of the resuscitation program, as shown:

$$\frac{\text{long term survivors}}{\text{hospital deaths plus long term survivors}} = \text{percent}$$

That number relates to the percent of patients who would otherwise have perished but instead were discharged from the hospital without evident neurologic or cardiopulmonary residua from their cardiopulmonary arrest. Those data are presented in Tables 2 and 3, summarizing data covering the total number of hospital and CCU patients.

An index of the application of CPR throughout the hospital is calculated by dividing the total CPR's by the sum of hospital deaths plus long-

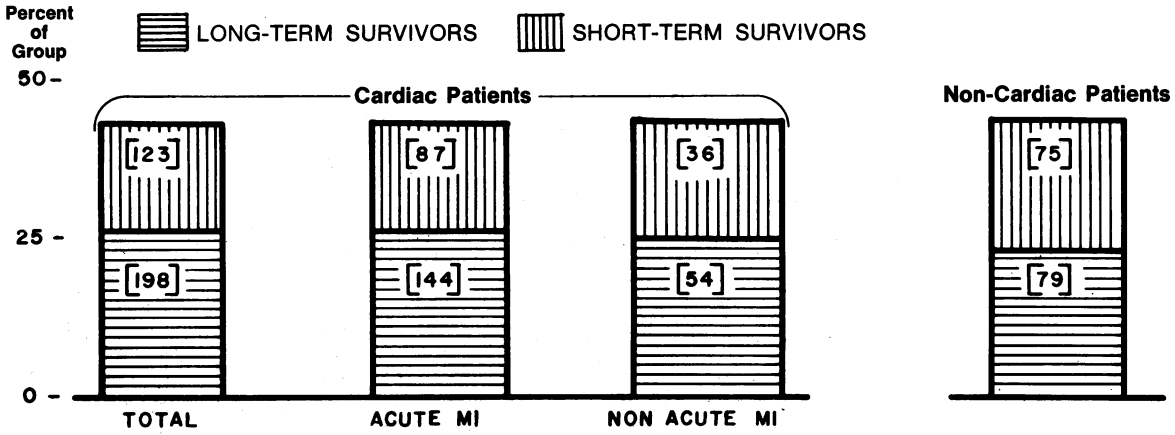

Figure 3.—Percentages of long-term and short-term survivors as they relate to the presence or absence of cardiac disease. Numbers in brackets represent total number of patients in that group (1965-1974).

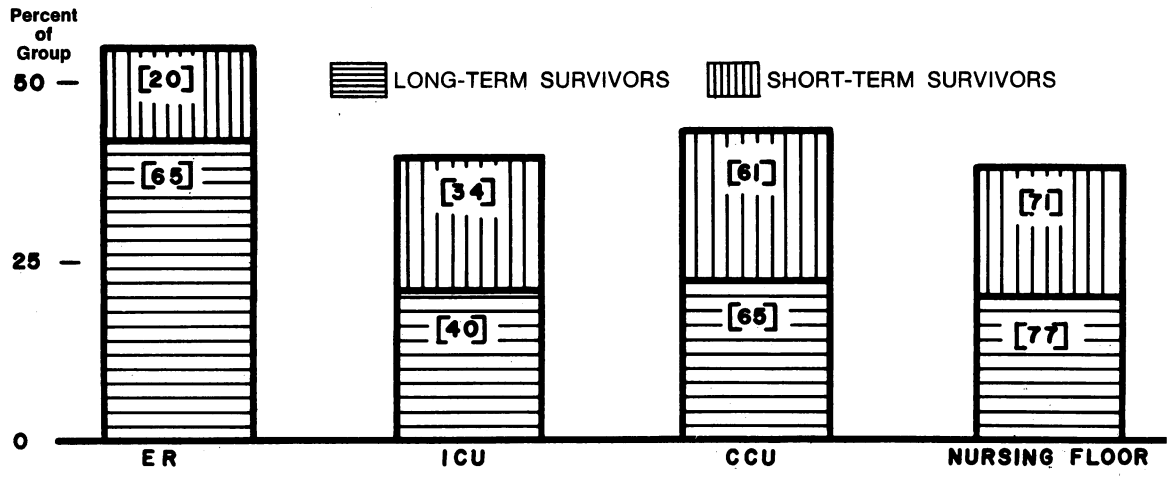

Figure 4.—Percentages of long-term and short-term survivors as they relate to patient location within hospital (1967-1974). Numbers of patients are in brackets.

term survivors. The total hospital ratio was 255/4333 or 5.9 percent, and in CCU 60/380 or 21 percent.

Discussion

St. Joseph Medical Center is located in the San Fernando Valley of California, an area in the northern portion of Los Angeles County. It serves primarily the adjacent residential communities. Some 80 percent of patients admitted to hospital lived in the San Fernando Valley and less than 1 percent lived outside the Los Angeles area.

There had been no pronounced change in the type of services offered nor patient population treated during the ten years of CPR data collection.

The average hospital stay of the total hospital patient population was 6.7 days. The cardiac patients, the largest single subgroup in CPR statistics, had an averaged stay of 9.4 days.

Of the total hospital patient population, 26 percent were 65 years of age, or older. Of the cardiac patients, 54 percent were at least 65 years of age. A negative relationship between increasing age and long-term survival has been previously published[8] and was confirmed in an earlier report[1] from this institution.

Cardiac patients accounted for about 9 percent of the total hospital patient population.

The tabulation of overall hospital CPR experience shows a trend toward increase in the annual number of CPR's as well as the percentage of long-term and short-term survivors (see Figure 1). Total hospital admissions did not increase notably and were not the basis for the increasing numbers. A full-time group of physicians trained in emergency medicine and covering the ER 24 hours a day began their services July 1, 1973, and, therefore, were only present during the last year and a half of the study. The increase in total CPR's as well as the percent of short-term and long-term survivors relates primarily to increasing training and experience of hospital personnel. This improvement in CPR programs with time has been previously reported.[13]

The increase in electrocardiographic monitors was likely a contributing factor to the progressive increase in CPR frequency and success (see Figure 2). The relationship is surely not linear and the optimal number of these monitors for a

TABLE 2.—*The Effect of Successful (Long-Term) CPR Performance on Overall Hospital Mortality*

	1967	1968	1969	1970	1971	1972	1973	1974	1967-1974
Occupancy (Patient Days/Year) ...	115,654	117,372	118,704	118,159	115,366	118,316	119,503	126,153	949,227
Deaths	563	603	630	427	499	436	442	478	4,078
CPR Long-Term Survivors .	23	26	30	27	22	35	44	48	255
Deaths and CPR Long-Term Survivors ...	586	629	660	454	521	471	486	526	4,333
CPR Long-Term Survivors as a percent of Deaths and CPR Long-Term Survivors	4%	4%	5%	6%	4%	7%	9%	9%	5.9%

CPR = cardiopulmonary recuscitation

TABLE 3.—*The Effect of Successful (Long-Term) CPR Performance on CCU Mortality*

	1967	1968	1969	1970	1971	1972	1973	1974	1967-1974
Occupancy (Patient Days/Year)	1,612	1,721	1,871	1,992	2,471	2,436	2,340	2,564	17,007
Deaths	18	34	36	28	33	20	32	47	248
CPR Long-Term Survivors	10	9	9	8	4	7	10	9	66
Deaths and CPR Long-Term Survivors	28	43	45	36	37	27	42	56	314
CPR Long-Term Survivors as a Percent of Deaths and CPR Long-Term Survivors	36%	21%	20%	22%	11%	26%	24%	16%	21%

CCU = coronary care unit
CPR = cardiopulmonary recuscitation

successful CPR program cannot be presented. Theoretically it would be optimal to monitor every hospital patient from admission to discharge. The cost of such an approach in terms of personnel, equipment purchase and maintenance does not appear feasible at this time. Nevertheless, concentration of patients at higher than average risk of cardiopulmonary arrest in critical care (ICU/CCU/ER) nursing units is a logical alternative.

The number of CPR's decreased in the last two years of the study as the number of electrocardiographic monitors increased. This observation raises the question as to whether some cardiopulmonary arrests were prevented by recognition and early treatment of premonitory, dangerous arrhythmias.

Illness

Two thirds of patients undergoing CPR had cardiac disease and nearly half had acute myocardial infarction as the underlying basis for cardiopulmonary arrest. Because cardiac patients constitute a relatively small percentage of the total hospital population, selection of this group of patients for more intensive monitoring seems indicated. The type of monitoring indicated is outside the scope of this study. If acute cardiac arrhythmias are the primary basis for arrest, then electrocardiographic monitoring would be the technique of choice. This approach has been described previously.[14] Other techniques for monitoring critically ill patients, such as on-line arterial blood gas analysis, may be indicated in the future.[15,16]

The incidence of both short-term and long-term survivors is surprisingly similar when comparing cardiac patients, with or without acute myocardial infarction, and other patients. This observation came as a surprise. The basis for this pronounced similarity among diverse groups is uncertain.

Location in Hospital

Almost two thirds of CPR patients were being treated in the critical care areas (ICU/CCU/ER) at the time of the arrest. This group plus the electrocardiographic monitored patients in the specialized nursing care units account for over two thirds of CPR patients in the later years of this study. In other words, most of the patients destined to suffer a cardiopulmonary arrest had already been identified as requiring greater care than that available in a nonmonitored nursing unit. The other possibility—that patients who are not being monitored will less frequently receive needed CPR—cannot be rejected completely. Personal observations during the last five years of the study showed that acutely ill patients with cardiac disease were seldom in an unmonitored nursing unit.

The ER had the largest percent of long-term survivors, a testimony to the ER medical and nursing staff's abilities to successfully manage acutely ill patients.

CPR and Its Effect on In-Hospital Mortality

Evaluation of the success of a CPR program is difficult. The number of short-term and long-term survivors does not relate to total hospital admissions, discharges or occupancy. The populations served by various hospitals may be very dissimilar in age or underlying pathologic conditions.

The relation of short-term and long-term survivors to the total number of CPR patients is helpful in evaluating the CPR program. Those data are presented.

The ultimate goal of a CPR program is the hospital discharge in prearrest condition of patients who have died—that is, undergone a cardiopulmonary arrest. The number of long-term and short-term survivors reflects upon the successful implementation of a CPR procedure, but the successful discharge of a neurologically intact patient is what really counts.

If we assume that patients who have had a cardiopulmonary arrest would die in the absence of CPR, then the addition of the number of long-term survivors to the number of patient deaths would reflect the expected number of deaths in the absence of CPR.

If the figures presented represent an average hospital—and this writer has no way of speaking for or against that concept—then the number of hospital deaths would be 5.9 percent greater in the absence of CPR. This figure extrapolated to national or international levels is staggering.

The 21 percent success rate over eight years in the CCU is an even more impressive figure and is compatible with previous reports showing a pronounced decrease in mortality in patients with acute myocardial infarction since the inception of CCU's.

Conclusion

Ten years of in-hospital CPR experience is tabulated.

A technique for evaluating the impact of CPR on hospital mortality is presented. This technique is also applied to specific areas of the hospital.

The increasing magnitude and effectiveness of the CPR program over ten years is outlined.

The association between hospital location, electrocardiographic monitoring, patient illness and factors of long-term and short-term survival is considered. The lack of association between primary illness and long-term and short-term survival also is presented.

Patients at high risk, as shown by the necessity of CPR, are concentrated in critical care nursing units.

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Treatment of Corneal Herpes Simplex in Children

IN MY EXPERIENCE it has been far better to use ointment rather than drops in treating corneal herpes simplex in children. Remember, to put drops into the eyes of a struggling infant or youngster is almost impossible when the child is not cooperative. And of course if he is crying the drops are diluted immediately and washed out, so there really is little effect. You also have to be careful about drug application. I have seen a patient diagnosed as having a dendritic lesion of the cornea, a two-year-old child, and we prescribed doxuridane (IDU) ointment every four hours, five times a day. The patient was brought back two days later . . . and the lesion had enlarged. Well, either that patient was IDU-resistant or the drug was not getting in properly. I asked the mother, "How did you put the drug in?" And she took some ointment and squeezed it out onto her little finger and rubbed it into the upper lid. And I do not think that is an isolated instance.

—PETER R. LAIBSON, MD, *Philadelphia*

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